

HDice Technical Note #23

Parameters and Conditions of the Feb'12 and Mar'12 eHD test runs

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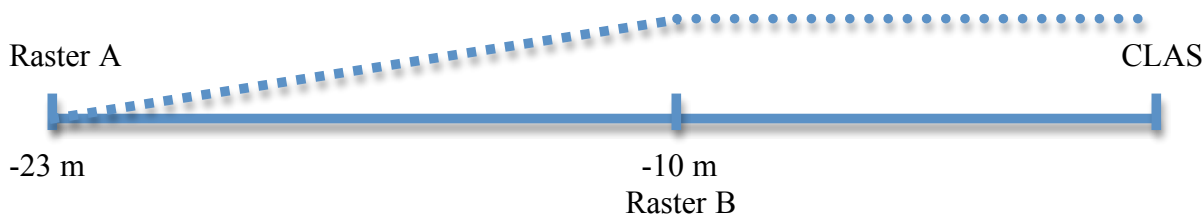
(last updated Apr 2, 2013)

Abstract

The parameters and characteristics of polarized HD during electron bombardment were studied in two tests runs conducted in February'12 and March'12. This report summarizes the conditions of these measurements.

Hall B Slow Raster

The old Hall B slow raster was used, giving two dipole kicks to the beam. The first (A) gave an angular spread to the beam and the second (B) was intended to undo the same bends in order to produce an enlarged parallel beam on target. (Unfortunately, one of the second magnets was initially wired with the same sign as the first set so that the result was an enlarged ellipse on target for the first 3 doses of the Feb'12 period.) The cycle period was set to 5 sec during the Feb'12 test and to 1 sec during the Mar'12 test period.



The Raster Scale was programmed in mV with the following calibration:

100 mV * Ee(GeV) = 9 mm; (eg. 525 mV \leftrightarrow 14.3 mm OD w 3 pass) ; cycle time was 5 sec in Feb'12 and 1 sec in Mar'12.

Feb'12 test run

This first eHD test was conducted between Feb 22 and Mar 2, 2012, using HD target 21a (*Silver*) and a 3 pass 3.3 GeV beam. Ten exposures to electron beams were carried out, interspersed with periods of NMR measurements. The spot was an ellipse during the first 3 doses. This was fixed after the 3rd dose. The magnetic field was 0.9 tesla through dose 1 – 9, and 0.3 tesla during dose 10. The characteristics of the 10 doses are listed below. The right most column, V_{core}/V_{tot} , gives the fraction of the rastered beam within the target. (For doses 4-10, this is just the raster area/tgt area.)

- | | V_{core}/V_{tot} |
|---|--------------------|
| <ul style="list-style-type: none">• 1st dose, Wed Feb 22, 22:00 – Feb 23, 00:30,<ul style="list-style-type: none">- 0.1 nA for 120 min + 0.5 nA for 60 min,raster: 149 (wrong sign) X 149 => 10.4 x 4.1 mm oval; $A = \pi * 5.2 * 2.0 \text{ mm}^2$- mix1 max = 90 - 120 mK, <105 mK>- run 68962 + 68963 (not saved properly)- dose ~ $[0.1 * 120 + 0.5 * 60] * 0.8 = \mathbf{34 \text{ nA-min}}$ | 0.19 |
| <ul style="list-style-type: none">• 2nd dose, Thur Feb 23, 23:10 – Feb 24, 02:10,<ul style="list-style-type: none">- 0.1 nA for 120 min + 0.5 nA for 60 min, but <u>40 sec of beam on tgt without raster</u>- mix1 max = 140 mKraster: 300 (wrong sign) X 300 = 20.8 x 8.2 mm oval; $A = \pi * 10.4 * 4.1 \text{ mm}^2$- run 68969 = 60.2 nA-min | 0.62 |

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- 3rd dose, Sat Feb 25, ~4am, 0.3 nA for ~5 min tot
 - **0.3 nA** nominal, with beam hitting MIX; jumps in temp to 400 mK
 - mix1 max = **90 mK + jumps**
 - raster: 300 (wrong sign) X 300 = 20.8 x 8.2 mm oval; $A = \pi * 10.4 * 4.1 \text{ mm}^2$
 - no recorded run**0.62**
- 4th dose, Sat Feb 25, 2pm – 5 pm, 1 nA for 76 min
 - **1.0 nA** nominal, clean
 - mix1 max = **160 mK**
 - raster: 375 X 375 = 10.2 mm OD (polarity fixed)
 - run **68971 = 64.9 nA-min****0.56**
- 5th dose, Sat Feb 25, 9:45pm – Sun Feb 26, 2pm
 - **1.0 nA** nominal,
 - but, beam hitting MIX for 4 hours which doubled temp to 250-300 mK
 - mix1 max = **160 – 280 mK**
 - raster: 375 X 375 = 10.2 mm OD
 - run **68977 + 68978 = 300.1 + 155.6 = 455.7 nA-min****0.56**
- 6th dose, Mon Feb 27, 16:30 – Tues Feb 28 8:00,
 - **1.0 nA** nominal, clean
 - mix1 max = **160 mK**
 - raster: 500 X 500 = 13.6 mm OD
 - run **68980 = 541 nA-min****0.82**
- 7th dose, Thur Mar 1, 01:30 – 9:00;
 - **0.25 nA** nominal, clean
 - mix1 max = **96 mK**
 - raster: 375 X 375 = 10.2 mm OD
 - run **68983 = 66.4 nA-min**
 - 25% loss**0.56**
- 8th dose, Thur Mar 1, 12:00 – 15:00, 0.25 nA
 - **0.25 nA** nominal, awful beam
 - mix1 max = **92 mK**
 - raster: 375 X 375 = 10.2 mm OD
 - run **68984 = 13.9 nA-min**
 - slight growth in pol**0.56**
- 9th dose, Thur Mar 1, 19:00 - Fri Mar 2, 9:00
 - **0.25 nA** nominal, clean - OK beam 2/3 of the time due to trips
 - mix1 max = **92 mK**
 - raster: 200 X 200 = 5.5 mm OD
 - run **68985 + 68986 = 132 nA-min tot****0.13**

- 10th dose, Fri Mar 2, 21:40 – Sat Mar 3, 8:40
 - **0.25 nA** nominal, beam seems to have wings; strips on various viewers
 - mix1 max = **94 mK**
 - raster: started off at 425 X 425 = 11.6 mm OD;
 - at 00:20 reduced raster to 375 x 375 = 10.2 mm because of halo cnt trips
 - continuous NMR scan during run; B ~ 0.3 tesla
 - run **68989 + 68990 = 45 nA-min**

0.60

A graphical history of the H polarization is shown in figure 1 below (with polarization values from A. Deur) together with a schematic representation of the raster size. The yellow bands in the graph represent beam-on periods. The black circle in the upper right represents the cross section of the target cell and the different colored curves show to the same scale the size of the rastered beam on target.

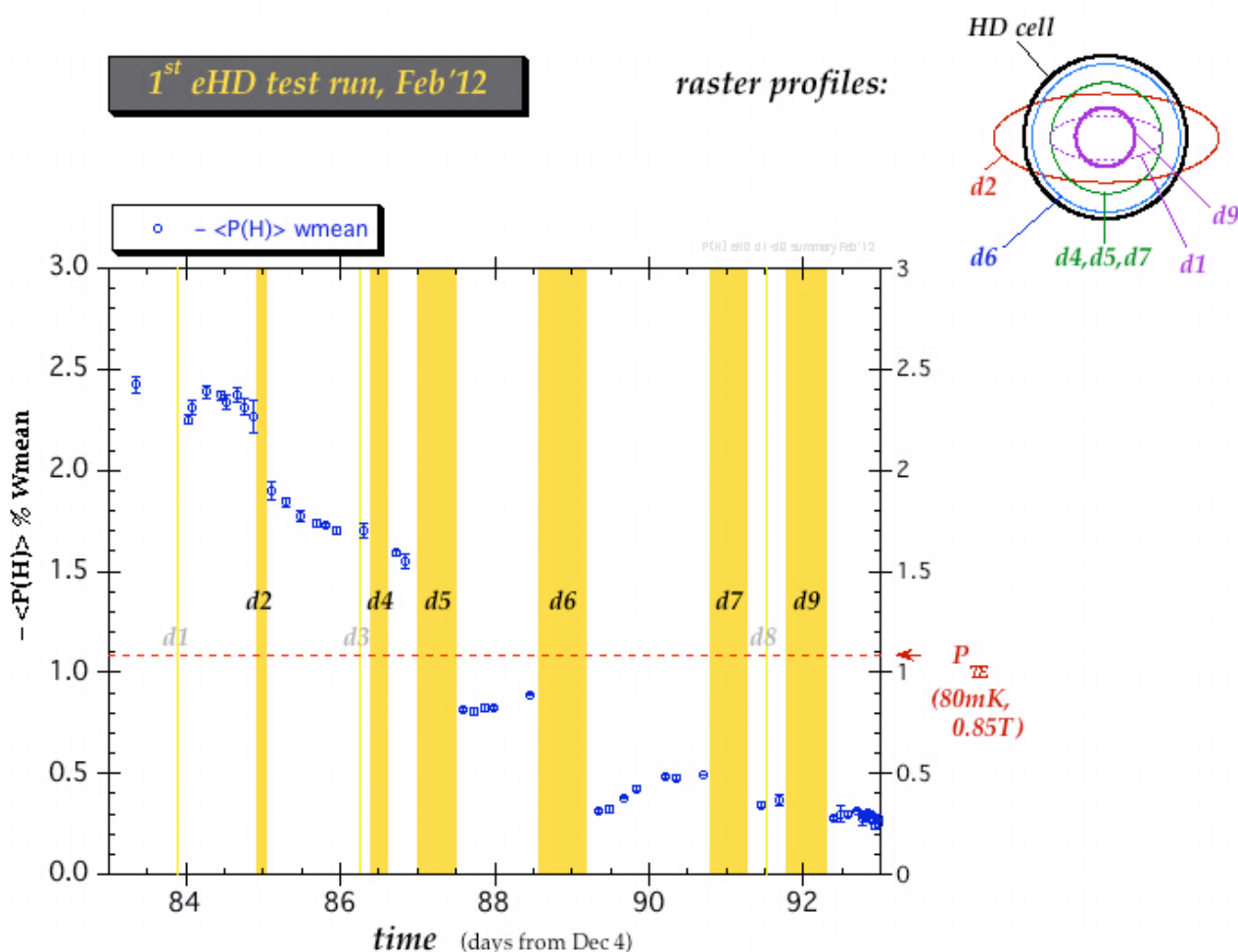


Figure 1. $P(H)$ during the Feb'12 eHD test – NMR values from A. Deur.

Mar'12 test run

This second eHD test was conducted between Mar 29 and Apr 1, 2012, using HD target 20b and a 5 pass 5.5 GeV beam. Two exposures to electron beams were carried out, interspersed with periods of NMR.

- 1st dose, started 19:30 on 3/29/12, 0.100 nA
the intention was to blow the beam up with quads and run 100 pA overnight, but stable beam lasted only a few hours; this dose period had 3 sub periods:
 - **d1a:** 100 pA nominal, clean for a few hours, w raster setting of **365 x 365 mV**
dose $\sim 0.1 \text{ na} * 180\text{min} * 0.9 = \mathbf{16 \text{ nA-min}}$
 - **d1b:** then multiple trips for a few hours with $\sim 80 \text{ pA}$;
 - **d1c:** then a few pA (~ 8) until morning w raster setting of **364 x 252 mV**
 - mix1 max = 90 mK
raster: **365 x 365 mV**, and **cycle time of 1 s** => spot size = **6.0 mm OD** => $V_{\text{core}}/V_{\text{tot}} = \mathbf{0.16}$
 - run **69178**
 - magnetic field = 0.29 tesla with NMR scanning every 15 min
- 2nd eHD dose started 3/31/12, $\sim 17:00$
 - **d2:** raster to **824 x 824 mV**, and **cycle time of 1 sec**
=> spot size = **13.5 mm OD** => $V_{\text{core}}/V_{\text{tot}} = \mathbf{0.81}$
 - <mix> $\sim 170 \text{ mK}$, with spikes.
 - current was $\sim 1 \text{ nA}$
- At the end of dose 2 on Apr 1, the field was zeroed, and then restored after \sim hour (to check if the target was still in a frozen spin state).

There was some confusion regarding the start and stop times because the NMR clock is different from epics time. The relation is in the table below.

Period 2 time sequence:

	Calendar time	NMR clock time (days)
d1a (100 pA) start	Mar 29'12 @ 19:15	15.802 (15.719_V)
d1a (100 pA) stop	Mar 29'12 @ 22:15	15.927 (15.844_V)
d1b (80 pA) start	Mar 30'12 @ 00:00	15.917
d1b (80 pA) stop	Mar 30'12 @ 00:45	15.948
d1c (8 pA) start	Mar 30'12 @ 02:15	16.010
d1c (8 pA) stop	Mar 30'12 @ 08:00	16.250
d2 (1 nA) start	Mar 31'12 @ 17:00	17.660 (17.625_V)
d2 (1 nA) stop	Apr 01'12 @ 06:45	18.191 (18.185_V)

A graphical history of the H polarization is shown in figure 2 below (with polarization values from A. Deur), together with a schematic representation of the raster size. The yellow bands in the graph represent beam-on periods. The black circle in the upper right represents the cross section of the target cell and the different colored curves show to the same scale the size of the rastered beam on target.

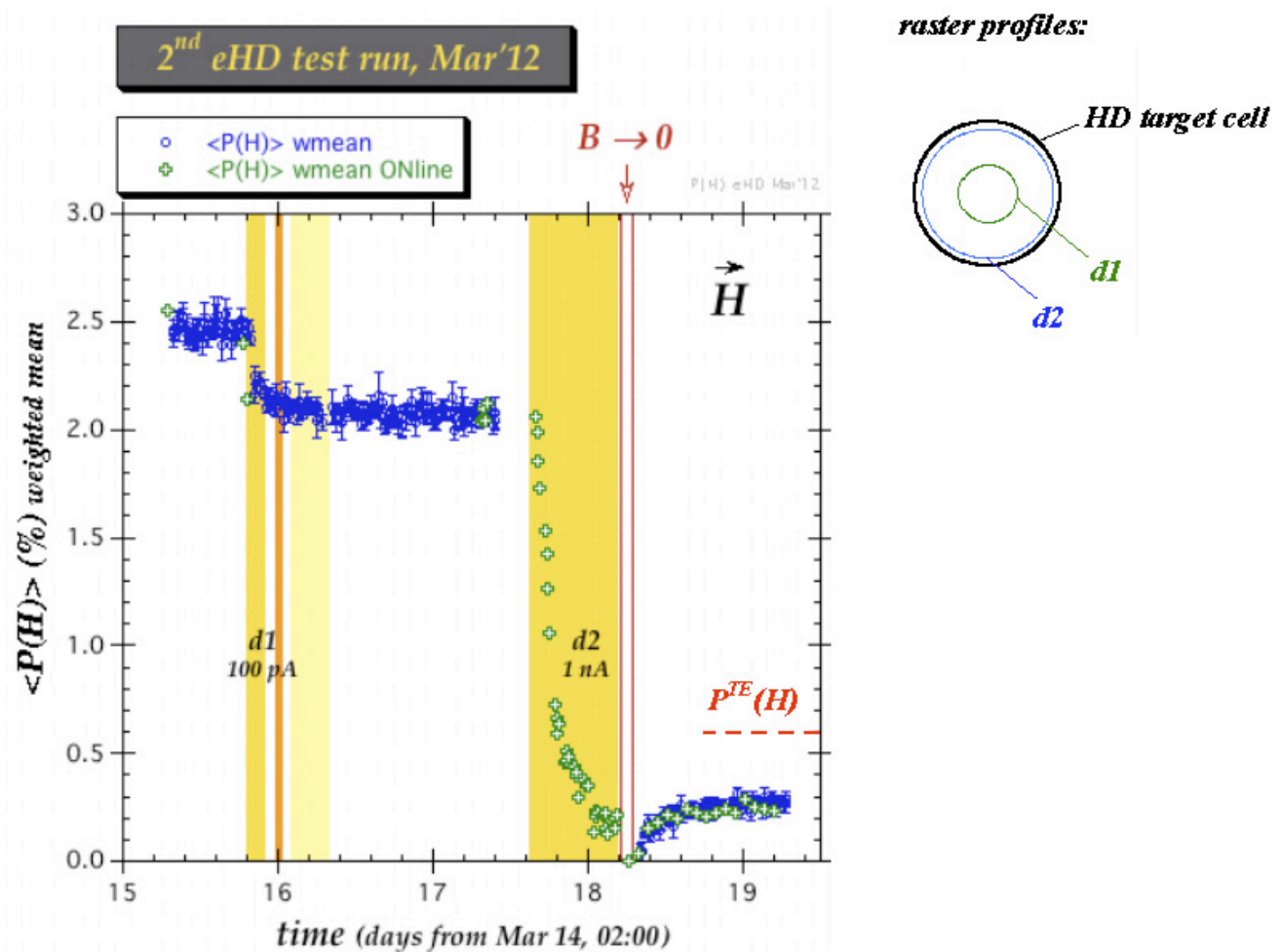


Figure 2. $P(H)$ during the Mar'12 eHD test – NMR values from A. Deur.

Summary of dose conditions

The raster size within the target is plotted in the top panel of figure 3 for the various dose exposures during the Feb'12 and Mar'12 eHD test runs. The electron currents used are summarized in the middle panel, together with the beam-on IBC mixing temperatures during the exposures. The latter essentially fall into one of two categories, either about 90 mK during low currents or about 160 mK during higher currents. The x and y dimensions of the intrinsic (*unrastered*) beam spot, as recorded by HARP scans before the dose periods, are shown in the bottom panel. (No HARP data is available for *dose 9*.)

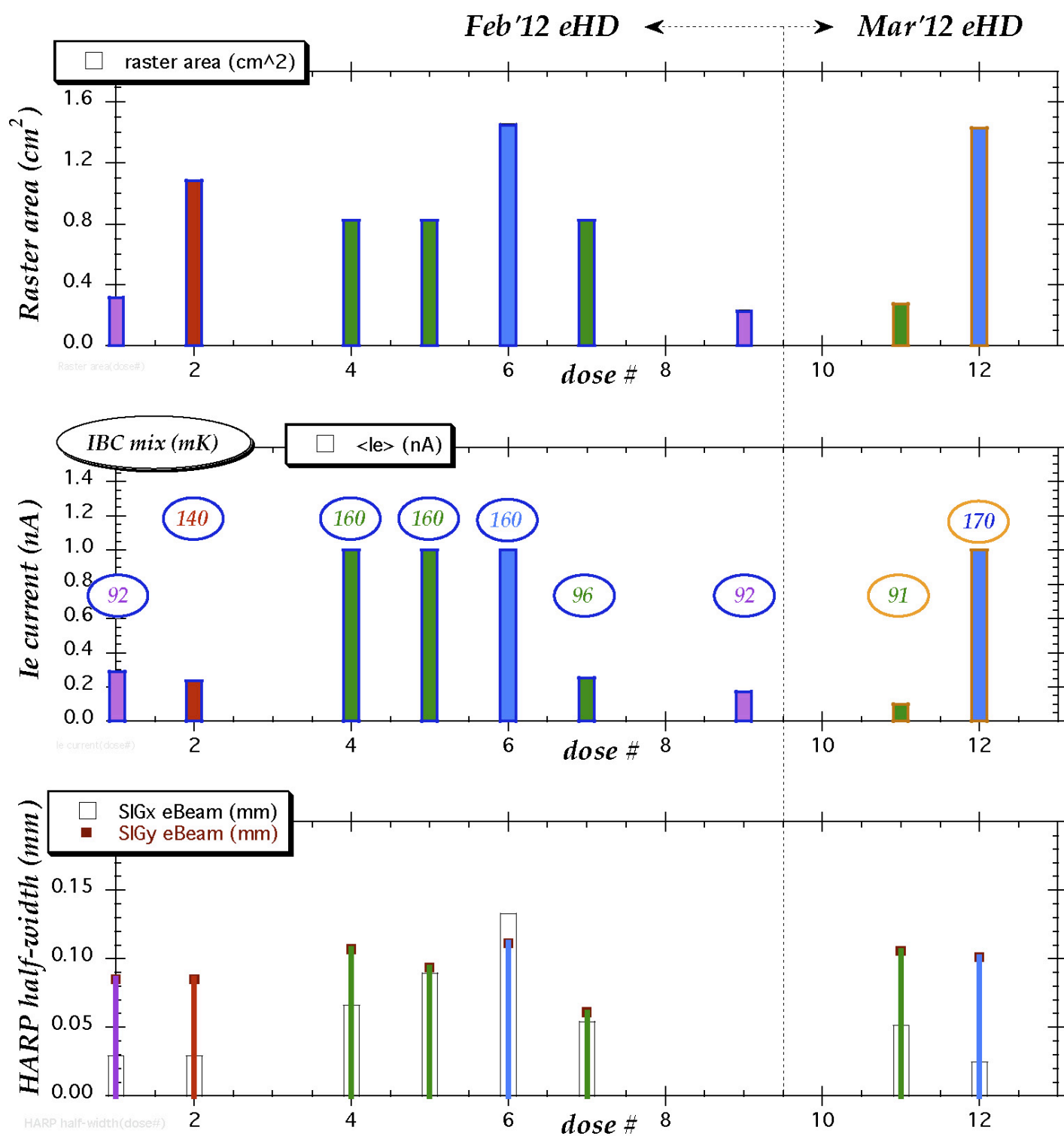


Figure 3. The raster areas within the target cell are histogrammed in the top panel for the Feb'12 and Mar'12 eHD tests. The colors correspond to those shown in the schematics at the upper right of figures 1 and 2. The electron currents are shown in the middle panel where the mixing chamber temperatures during the dose exposures are also indicated in mK. The x and y dimensions of the intrinsic (*unrastered*) beam spot, as recorded by HARP scans before the dose periods, are shown in the bottom panel, with the x size as an open bar and the y as solid bar. (No HARP data is available for dose 9.)